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CONNEAUT LAKE, CRAWFORD COUNTY, PENNSYLVANIA

Pacific Northwest Environmental Research Laboratory

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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REPORT

ON

CONNEAUT LAKE

CRAWFORD COUNTY

PENNSYLVANIA

EPA REGION III

WORKING PAPER No. 417

WITH THE COOPERATION OF THE

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES

AND THE

PENNSYLVANIA NATIONAL GUARD

JUNE, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Pennsylvania Department of Environmental Resources for professional involvement and to the Pennsylvania National Guard for conducting the tributary sampling phase of the Survey.

Walter A. Lyon, Director of the Bureau of Water Quality Management, Richard M. Boardman, Chief of the Division of Water Quality, and James T. Ulanoski, Aquatic Biologist of the Division of Water Quality, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

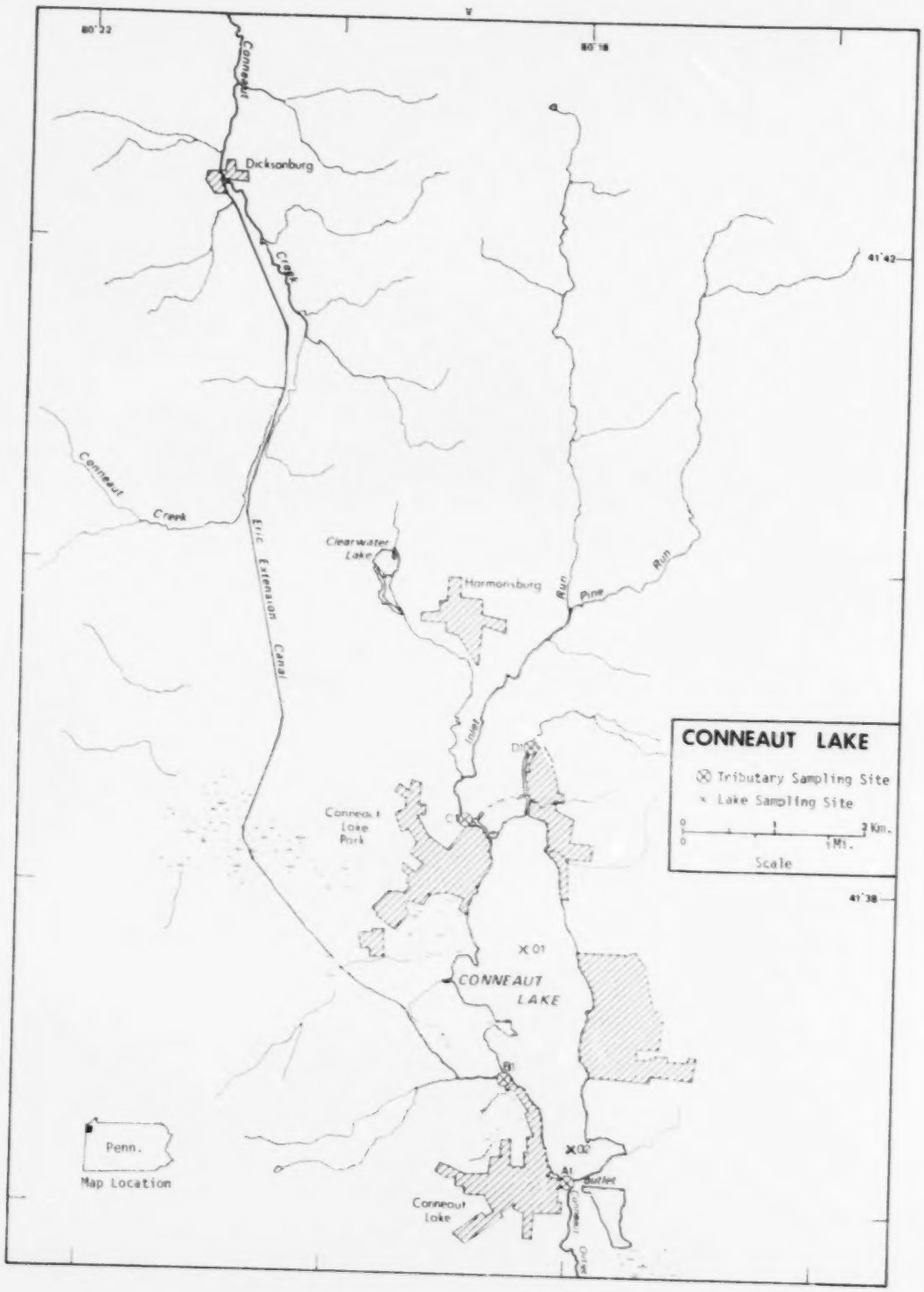
Major General Harry J. Mier, Jr., the Adjutant General of Pennsylvania, and Project Officer Major Ronald E. Wickard, who directed the volunteer efforts of the Pennsylvania National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF PENNSYLVANIA

LAKE NAME	COUNTY
Allegheny Reservoir	McKean, Warren, PA; Cattaraugus, NY
Beaver Run Reservoir	Westmoreland
Beltzville	Carbon
Blanchard Reservoir	Centre
Canadohta	Crawford
Conneaut	Crawford
Conewago (Pinchot)	York
Greenlane	Montgomery
Harveys	Luzerne
Indian	Somerset
Naomi	Monroe
Ontelaunee	Berks
Pocono	Monroe
Pymatuning Reservoir	Crawford, PA; Ashtabula, OH
Shenango River Reservoir	Mercer
Stillwater	Monroe
Wallenpaupack	Pike, Wayne


80°22
80°18
41°42
41°38
Conneaut
Dicksonburg
Creek
Conneaut
Creek
Erie Extension Canal
Clearwater
Lake
Harmonsburg
Pine Run
Inlet
Conneaut
Lake
Park
X 01
CONNEAUT
LAKE
X 02
Outlet
Conneaut
Lake
CONNEAUT LAKE
Tributary Sampling Site
Lake Sampling Site
0 1 2 Km.
0 1 Mi.
Scale
Penn.
Map Location

CONNEAUT LAKE*

STORET NO. 4204

I. CONCLUSIONS

A. Trophic Condition:

Survey data and a report by others (Ketelle and Uttormark, 1971) indicate that Conneaut Lake is eutrophic. It ranked eleventh in overall trophic quality when the 17 Pennsylvania lakes sampled in 1973 were compared using a combination of six lake parameters**. Nine of the lakes had less median total phosphorus, nine had less and one had the same median dissolved phosphorus, seven had less median inorganic nitrogen, seven had less mean chlorophyll a, and five had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at both sampling stations in July and at station 1 in October, 1973.

Survey limnologists did not observe any algal concentrations but noted the occurrence of submerged and emergent aquatic vegetation in the cove to the east of sampling station 2.

B. Rate-Limiting Nutrient:

There was a significant loss of phosphorus between the time of sample collection and the beginning of the assay and the results are not representative of conditions in the lake at the time the sample was taken.

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* Table of metric conversions--Appendix A.
** See Appendix B.

The lake data indicate phosphorus limitation in April but nitrogen limitation in July and October.

C. Nutrient Controllability:

1. Point sources--There were no known phosphorus point sources during the sampling year. Shoreline dwellings are served by a wastewater treatment plant which discharges to the outlet stream.

Wild ducks and geese were estimated to have contributed less than 2% of the phosphorus load.

The present loading rate of 0.51 $g/m^2/yr$ is well below that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic rate (see page 13). Nonetheless, the lake is eutrophic, and all phosphorus inputs should be minimized to the greatest practicable degree.

2. Non-point sources--The phosphorus load from non-point sources, including precipitation, amounted to 98.4% of the total load reaching the lake during the sampling year. The unnamed streams B-1 and D-1 contributed 39.2% of the total while minor tributaries and immediate drainage were estimated to have contributed 55.8% of the total phosphorus load. The ungaged drainage area of Conneaut Lake includes a major portion of the total drainage area (58%); consequently, the load is quite large (sampling at station C-1 was complicated by high

water levels of the lake during the year, and the drainage area for this station was included in the "ungaged area").

The non-point phosphorus export rates of the sampled tributaries ranged from 22 to 31 kg/km^2/yr during the sampling year (see page 12). These rates are somewhat higher than those of unimpacted Pennsylvania streams sampled elsewhere and may be due to unidentified point source discharges.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 3.78 kilometers^2.
2. Mean depth: 7.3 meters.
3. Maximum depth: 20.1 meters.
4. Volume: 27.594 x 10^6 m^3.
5. Mean hydraulic retention time: 106 days (based on outlet flow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Unnamed Stream (B-1)	4.6	0.1
Unnamed Stream (D-1)	20.8	0.5
Minor tributaries & immediate drainage -	40.5	2.0
Totals	65.9	2.6

2. Outlet -

Conneaut outlet	69.7**	3.0

C. Precipitation***:

1. Year of sampling: 116.0 centimeters.
2. Mean annual: 102.8 centimeters.

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† Ulanoski, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Conneaut Lake was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 14.6 meters at station 1 and 9.1 meters at station 2.

The lake sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR CONNEAUT LAKE
STORET CODE 4204

PARAMETER	1ST SAMPLING (4/21/73) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/27/73) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/ 5/73) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	8.7 - 12.8	10.4	9.9	12.3 - 25.0	21.6	24.6	12.8 - 18.1	16.5	17.8
DISS OXY (MG/L)	10.9 - 11.7	11.3	11.3	0.4 - 8.0	4.2	4.2	3.2 - 7.8	6.7	7.2
CNDCTVY (MCROMO)	185. - 200.	189.	190.	151. - 190.	178.	189.	167. - 179.	170.	168.
PH (STAND UNITS)	7.5 - 8.3	8.0	8.0	7.0 - 8.4	7.7	7.9	7.0 - 7.4	7.2	7.3
TOT ALK (MG/L)	59. - 60.	60.	60.	72. - 81.	74.	74.	64. - 91.	72.	66.
TOT P (MG/L)	0.015 - 0.024	0.019	0.018	0.020 - 0.103	0.033	0.022	0.016 - 0.325	0.086	0.029
ORTHO P (MG/L)	0.004 - 0.011	0.005	0.005	0.003 - 0.062	0.013	0.006	0.005 - 0.111	0.032	0.012
NO2+NO3 (MG/L)	0.200 - 0.220	0.209	0.210	0.020 - 0.050	0.034	0.040	0.020 - 0.030	0.024	0.030
AMMONIA (MG/L)	0.030 - 0.040	0.035	0.040	0.040 - 0.560	0.115	0.050	0.090 - 1.420	0.396	0.110
KJEL N (MG/L)	0.400 - 0.600	0.475	0.500	0.400 - 1.200	0.575	0.500	0.800 - 2.100	1.150	0.900
INORG N (MG/L)	0.230 - 0.260	0.245	0.250	0.060 - 0.600	0.154	0.090	0.120 - 1.450	0.425	0.140
TOTAL N (MG/L)	0.610 - 0.810	0.684	0.700	0.440 - 1.240	0.614	0.530	0.830 - 2.130	1.179	0.930
CHLRPYL A (UG/L)	3.1 - 5.0	4.0	4.0	7.4 - 7.5	7.4	7.4	5.9 - 16.5	11.2	11.2
SECCHI (METERS)	2.6 - 2.7	2.7	2.7	2.4 - 2.7	2.6	2.6	2.0 - 2.4	2.2	2.2

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/21/73	1. Flagellates	335
	2. Asterionella	220
	3. Cyclotella	176
	4. Stephanodiscus	132
	5. Fragilaria	97
	Other genera	27
	Total	987
07/27/73	1. Anabaena	228
	2. Stephanodiscus	178
	3. Cryptomonas	152
	4. Dinobryon	127
	5. Flagellates	102
	Other genera	204
	Total	991
10/05/73	1. Anabaena	145
	2. Stephanodiscus	105
	3. Flagellates	105
	4. Cryptomonas	53
	5. Ceratium	26
	Other genera	79
	Total	513

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
04/21/73	01	3.1
	02	5.0
07/27/73	01	7.5
	02	7.4
10/05/73	01	16.5
	02	5.9

C. Limiting Nutrient Study:

There was a 16% loss of orthophosphorus between the time of sample collection and the beginning of the assay, and the results are not representative of conditions in the lake at the time the sample was taken.

The lake data indicate phosphorus limitation in April (the N/P ratio was 41/1), nitrogen limitation in July (N/P = 12/1), and a borderline nitrogen limitation in October (N/P = 13/1).

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Pennsylvania National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of February when two samples were collected. Sampling was begun in May, 1973, and was completed in April, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Pennsylvania District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient exports, in $kg/km^2/year$, at stations B-1 and D-1 and multiplying the means by the ZZ area in km^2.

Nutrient loads for station C-1 were not calculated because of inundation of the sampling site during part of the year when high lake water levels occurred; however, the analytical data are included in Appendix E.

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* See Working Paper No. 175.

Estimates of nutrient contributions by wild ducks and geese were based on the following numbers of waterfowl using Conneaut Lake as provided by the Pennsylvania Department of Environmental Resources (Ulanoski, 1975):

Summer resident ducks	50
Summer resident geese	50
Migratory ducks	1,000
Migratory geese	300

In calculating the nutrient loads, the following assumptions were made:

1. Each wild duck contributes 0.45 kg total nitrogen and 0.20 kg total phosphorus per year (Paloumpis and Starrett, 1960).

2. Each wild goose contributes the same amount as one duck since geese typically feed in fields away from the lake several hours each day.

3. Summer or winter resident waterfowl are at the lake for six months of the year.

4. Migratory waterfowl spend a total of one month per year at the lake; i.e., 15 days during Spring migration and 15 days during Fall migration.

A. Point Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Unnamed Stream (B-1)	100	5.2
Unnamed Stream (D-1)	655	34.0
b. Minor tributaries & immediate drainage (non-point load) -	1,075	55.8
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Ducks and geese -	30	1.6
g. Direct precipitation* -	65	3.4
Total	1,925	100.0

2. Outputs -

Lake outlet - Conneaut outlet 1,345

3. Net annual P accumulation - 580 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Unnamed Stream (B-1)	2,310	4.7
Unnamed Stream (D-1)	17,885	36.6
b. Minor tributaries & immediate drainage (non-point load) -	27,580	56.4
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Ducks and geese -	70	0.1
g. Direct precipitation* -	4,080	8.2
Total	48,925	100.0

2. Outputs -

Lake outlet - Conneaut outlet 65,515

3. Net annual N loss - 16,590 kg.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Unnamed Stream (B-1)	22	502
Unnamed Stream (D-1)	31	860

* See Working Paper No. 175.

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.51	0.15	12.9	loss*

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Conneaut Lake:

"Dangerous" (eutrophic rate)	0.96
"Permissible" (oligotrophic rate)	0.48

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the lake, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, unknown and unsampled point sources discharging directly to the lake, or underestimation of the minor tributary and immediate drainage load. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which has been intensively studied by EPA's National Eutrophication and Lake Restoration Branch (Malueg, et al., 1975).

V. LITERATURE REVIEWED

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VII. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

LAKE RANKINGS

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4224	LAKE NAOMI	445
2	4220	BELTZVILLE DAM	423
3	4222	HARVEY'S LAKE	413
4	4228	STILLWATER LAKE	401
5	4227	POCONO LAKE	389
6	4223	INDIAN LAKE	388
7	3641	ALLEGHENY RESERVOIR	385
8	4229	LAKE WALLENPAUPACK	371
9	4221	CANADOHTA LAKE	369
10	4219	BEAVER RUN RESERVOIR	360
11	4204	CONNEAUT LAKE	307
12	4226	PINCHOT LAKE	256
13	4213	PYMATUNING RESERVOIR	206
14	4216	SHENANGO RIVER RESERVOIR	157
15	4225	ONTELAUNEE DAM	101
16	4201	BLANCHARD RESERVOIR	85
17	4207	GREENLANE DAM	53

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS P	INDEX NO
3641	ALLEGHENY RESERVOIR	56 (9)	38 (6)	63 (10)	100 (16)	69 (11)	59 (8)	365
4201	BLANCHARD RESERVOIR	13 (2)	13 (2)	25 (4)	31 (5)	3 (0)	0 (0)	85
4204	CONNEAUT LAKE	44 (7)	63 (10)	69 (11)	56 (9)	34 (5)	41 (6)	307
4207	GREENLANE DAM	6 (1)	6 (1)	19 (3)	13 (2)	3 (0)	6 (1)	53
4213	PYMATUNING RESERVOIR	0 (0)	72 (11)	6 (1)	0 (0)	100 (16)	28 (4)	206
4216	SHENANGO RIVER RESERVOIR	19 (3)	44 (7)	13 (2)	6 (1)	47 (7)	28 (4)	157
4219	BEAVER RUN RESERVOIR	94 (15)	19 (3)	88 (14)	81 (13)	19 (2)	59 (8)	360
4220	BELTZVILLE DAM	88 (14)	25 (4)	94 (15)	94 (15)	34 (5)	88 (13)	423
4221	CANADOHTA LAKE	50 (8)	97 (15)	56 (9)	19 (3)	59 (9)	88 (13)	369
4222	HARVEY'S LAKE	63 (10)	81 (13)	100 (16)	63 (10)	47 (7)	59 (8)	413
4223	INDIAN LAKE	100 (16)	31 (5)	75 (12)	75 (12)	19 (2)	88 (13)	388
4224	LAKE NAOMI	81 (13)	88 (14)	44 (7)	69 (11)	88 (14)	75 (12)	445
4225	ONTELAUNEE DAM	25 (4)	0 (0)	0 (0)	44 (7)	19 (2)	13 (2)	101
4226	PINCHOT LAKE	31 (5)	56 (9)	31 (5)	38 (6)	81 (13)	19 (3)	256
4227	POCONO LAKE	38 (6)	97 (15)	50 (8)	88 (14)	75 (12)	41 (6)	389
4228	STILLWATER LAKE	72 (11)	72 (11)	38 (6)	25 (4)	94 (15)	100 (16)	401
4229	LAKE WALLENPAUPACK	72 (11)	50 (8)	81 (13)	50 (8)	59 (9)	59 (8)	371

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS P
3641	ALLEGHENY RESERVOIR	0.016	0.380	414.250	3.700	13.800	0.006
4201	BLANCHARD RESERVOIR	0.064	1.300	453.143	15.187	14.900	0.046
4204	CONNEAUT LAKE	0.023	0.185	402.000	7.567	14.600	0.007
4207	GREENLANE DAM	0.066	1.475	460.222	24.011	14.900	0.020
4213	PYMATUNING RESERVOIR	0.070	0.180	467.750	56.333	7.700	0.008
4216	SHENANGO RIVER RESERVOIR	0.058	0.340	463.555	26.800	14.500	0.008
4219	BEAVER RUN RESERVOIR	0.009	0.835	384.833	5.183	14.800	0.006
4220	BELTZVILLE DAM	0.010	0.815	362.444	4.856	14.600	0.005
4221	CANADOHTA LAKE	0.020	0.130	436.000	19.167	14.100	0.005
4222	HARVEY'S LAKE	0.015	0.160	338.000	5.967	14.500	0.006
4223	INDIAN LAKE	0.008	0.520	400.222	5.211	14.800	0.005
4224	LAKE NAOMI	0.014	0.135	443.333	5.533	8.000	0.005
4225	ONTELAUNEE DAM	0.040	2.150	470.667	11.783	14.800	0.011
4226	PINCHOT LAKE	0.027	0.245	453.000	13.950	11.500	0.008
4227	POCONO LAKE	0.024	0.130	438.800	4.980	13.200	0.007
4228	STILLWATER LAKE	0.015	0.180	449.000	18.233	7.900	0.004
4229	LAKE WALLENPAUPACK	0.015	0.250	394.583	9.617	14.100	0.006

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR PENNSYLVANIA 1/21/75

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LAKE CODE 4204 CONNEAUT LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 594.1

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4204A1	544.1	3.40	3.48	3.16	3.48	2.69	2.27	1.81	1.36	1.44	2.15	3.96	3.96	2.98
4204B1	4.5	0.14	0.14	0.25	0.14	0.08	0.06	0.03	0.03	0.03	0.06	0.16	0.17	0.11
4204C1	27.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4204D1	20.4	0.29	0.53	1.15	0.76	0.31	0.27	0.20	0.11	0.12	0.25	0.68	0.74	0.48
4204Z1	44.3	2.13	2.35	3.23	2.52	1.70	1.44	1.19	0.88	0.91	1.36	2.52	2.52	1.89

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 594.1
SUM OF SUB-DRAINAGE AREAS = 45.9

TOTAL FLOW IN = 29.92
TOTAL FLOW OUT = 35.85

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4204A1	5	73	3.47	19	1.78				
	6	73	2.53	4	1.27				
	7	73	1.59	6	0.91				
	8	73	0.91	10	1.48				
	9	73	0.69	8	0.17				
	10	73	1.24	8	0.62				
	11	73	2.80	3	1.53				
	12	73	3.43	1	2.11				
	1	74	0.90	3	1.41				
	2	74	2.35	2	1.17				
	3	74	5.10	21	0.23				
	4	74	4.41	26	3.46				
4204B1	5	73	0.13	19	0.04				
	6	73	0.09	4	0.02				
	7	73	0.03	8	0.00				
	8	73	0.01	10	0.01				
	9	73	0.00	8	0.00				
	10	73	0.02	8	0.01				
	11	73	0.04	3	0.03				
	12	73	0.10	1	0.05				
	1	74	0.17	3	0.03				
	2	74	0.07	2	0.03				
	3	74	0.27	21	0.00				
	4	74	0.24	26	0.12				

TRIBUTARY FLOW INFORMATION FOR PENNSYLVANIA 1/27/75

LAKE CODE 4204 CONNEAUT LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4204C1	5	73	0.0	19	0.0				
	6	73	0.0	9	0.0				
	7	73	0.0	6	0.0				
	8	73	0.0	10	0.0				
	9	73	0.0	8	0.0				
	10	73	0.0	5	0.0				
	11	73	0.0	3	0.0				
	12	73	0.0	1	0.0				
	1	74	0.0	5	0.0				
	2	74	0.0	2	0.0				
	3	74	0.0	21	0.0				
	4	74	0.0	20	0.0				
4204D1	5	73	0.034	19	0.18				
	6	73	0.34	9	0.10				
	7	73	0.14	6	0.02				
	8	73	0.03	10	0.21				
	9	73	0.01	8	0.01				
	10	73	0.07	5	0.03				
	11	73	0.40	3	0.13				
	12	73	0.40	1	0.24				
	1	74	0.74	5	0.20				
	2	74	0.28	2	0.26				
	3	74	1.15	21	1.54				
	4	74	1.02	20	0.34				
4204Z1	5	73	2.13	19	1.13				
	6	73	1.04	9	0.82				
	7	73	1.02	6	0.31				
	8	73	0.57	10	1.25				
	9	73	0.18	8	0.11				
	10	73	0.05	5	0.40				
	11	73	1.78	3	0.95				
	12	73	1.41	1	1.30				
	1	74	0.25	5	1.19				
	2	74	1.35	2	1.19				
	3	74	3.23	21	3.95				
	4	74	3.45	20	2.13				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/01/27

420401
41 37 38.0 080 18 24.0
CONNEAUT LAKE
42039 PENNSYLVANIA

TEMPALES
3

2111202
0052 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/21	09 30	0000	12.8		108	200	7.30	59	0.030	0.500	0.200	0.007
	09 30	0004	12.8	11.5		190	7.80	59	0.040	0.400	0.210	0.011
	09 30	0020	9.3	10.9		185	7.90	60	0.040	0.400	0.210	0.008
	09 30	0035	8.8	10.9		185	8.00	60	0.040	0.400	0.210	0.005
73/07/27	16 25	0000	25.0		96	190	8.40	73	0.050	0.600	0.040	0.004
	16 25	0005	25.0	8.0		190	8.20	73	0.050	0.400	0.040	0.006
	16 25	0015	25.0	7.9		190	8.00	74	0.050	0.400	0.050	0.006
	16 25	0025	16.9	6.7		155	7.00	72	0.090	0.400	0.040	0.009
	16 25	0048	12.3	6.4		151	7.50	81	0.560	1.200	0.040	0.062
73/10/05	16 30	0000	18.1	7.8	78	170	7.30	64	0.090	0.800	0.030	0.005
	16 30	0015	17.9	7.2		167	7.30	66	0.110	0.800	0.030	0.010
	16 30	0033	16.0	5.2		168	7.20	71	0.320	1.200	0.030	0.014
	16 30	0033	13.7			174	7.00	91	0.920	1.700	0.020	0.087
	16 30	0044	12.8			174	7.10	84	1.420	2.100	0.030	0.111

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/21	09 30	0000	0.015	3.1
	09 30	0004	0.024	
	09 30	0020	0.023	
	09 30	0035	0.024	
73/07/27	16 25	0000	0.020	7.5
	16 25	0005	0.021	
	16 25	0015	0.022	
	16 25	0025	0.023	
	16 25	0048	0.103	
73/10/05	16 30	0000	0.018	10.3
	16 30	0015	0.024	
	16 30	0033	0.044	
	16 30	0035	0.150	
	16 30	0044	0.323	

STORET RETRIEVAL DATE 73/01/27

420402
41 36 22.0 080 17 57.0
CONNEAUT LAKE
42039 PENNSYLVANIA

ILEPALES
3

2111202
0022 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/21	10	15 0000	10.5		102	193	8.10	59	0.030	0.500	0.200	0.007
	10	15 0004	10.7	11.7		190	8.10	59	0.030	0.500	0.210	0.004
	10	15 0015	9.3	11.4		190	8.30	60	0.040	0.600	0.210	0.004
	10	15 0030	8.7	11.3		190	8.20	60	0.040	0.500	0.220	0.005
73/07/27	16	50 0000	24.5		108	189	8.00	73	0.040	0.500	0.020	0.007
	16	50 0005	24.0	7.6		188	7.90	74	0.040	0.600	0.040	0.010
	16	50 0018	19.7	6.8		187	7.80	75	0.040	0.500	0.040	0.003
73/10/05	17	05 0000	17.8	7.4	96	188		66	0.100	0.800	0.030	0.007
	17	05 0015	17.8	7.2		187	7.40	66	0.110	0.900	0.030	0.015
	17	05 0027	17.8	7.2		188	7.30	66	0.100	0.900	0.030	0.008

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/21	10	15 0000	0.019	7.0
	10	15 0004	0.016	
	10	15 0015	0.014	
	10	15 0030	0.017	
73/07/27	16	50 0000	0.022	7.4
	16	50 0005	0.023	
	16	50 0018	0.029	
73/10/05	17	05 0000	0.016	7.9
	17	05 0015	0.026	
	17	05 0027	0.032	

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 75/02/03

42044A1
41 36 12.0 080 18 00.6
CONNEAUT OUTLET
42021 1.5 CONNEAUT LK
O/CONNEAUT LAKE
US RT 6 BRDG AT OUTLET E OF TOWN
11EPALES 2111204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO3&NO2 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	
73/05/14	09 10		0.120	0.540	0.014	0.005	0.020	Q
73/06/04	09 30		0.074	0.520	0.048	0.005K	0.010	Q
73/07/05	09 40		0.019	0.440	0.020	0.005K	0.015	
73/08/11	09 55		0.010K	0.360	0.020	0.005K	0.025	
73/09/04	09 45		0.010K	0.880	0.037	0.015	0.040	
73/10/20	10 00		0.650	0.600	0.071	0.008	0.025	
73/11/05	15 00		0.068	0.600	0.124	0.005K	0.005K	
73/12/16	14 45		0.240	0.800	0.072	0.015	0.015	
74/01/05	09 00		0.270	0.400	0.060	0.005K	0.010	
74/02/03	14 45		0.384	0.500	0.030	0.005K	0.005	
74/02/18	14 45		0.232	0.300	0.055	0.005K	0.005K	
74/03/02	14 45		0.300	0.400	0.020	0.010	0.030	
74/04/20	12 45		0.200	0.300	0.015	0.005K	0.005	

K VALUE KNOWN TO BE
LESS THAN INDICATED

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STORET RETRIEVAL DATE 73/02/03

42 0481
41 30 47.0 080 18 30.0
UNNAMED CREEK
42 7.5 CONNEAUT LK
1/CONNEAUT LAKE
SEC 20 T03N R05W 41 W OF TOWN OF CONNEAUT
11EMALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00530 SUSPND SOLIDS TOTAL MG/L	00625 TOT KJEL N MG/L	00610 AMMONIA TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/03/19	09 30		0.031	0.350	0.010	0.013	0.030
73/06/04	09 40		0.100	0.500	0.041	0.023	0.030
73/07/05	09 45		0.170	0.340	0.033	0.019	0.040
73/08/11	10 00		0.022	0.440	0.032	0.023	0.100
73/09/05	10 00		0.012	0.440	0.024	0.022	0.032
73/10/20	10 15		0.020	0.450	0.033	0.013	0.040
73/11/04	09 30		0.140	0.500	0.024	0.012	0.025
73/12/18	15 00		0.320	0.500	0.032	0.008	0.010
74/01/05	09 15		0.358	0.200	0.018	0.005K	0.015
74/02/05	15 00		0.024	0.300	0.025	0.005K	0.010
74/02/15	15 00		0.032	0.200	0.020	0.005K	0.005K
74/03/02	15 00		0.116	0.500	0.045	0.023	0.033
74/04/20	15 00		0.142	0.350	0.015	0.005K	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 73/02/03

4204C1
41 38 25.0 080 18 55.0
INLET RUN
42 7.5 HARMONSBURG
T/CONNEAUT LAKE
PA HWY 618 BRDG JUST N OFCONNEAUT LK PK
FEMALES 2111204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/05/14	09 55		0.336	0.400	0.024	0.006	0.020
73/06/04	09 50		0.220	0.780	0.130	0.015	0.035
73/07/06	10 00		0.220	0.820	0.055	0.015	0.035
73/08/11	10 10		0.130	0.540	0.033	0.015	0.075
73/09/08	10 05		0.147	0.840	0.036	0.026	0.070
73/10/20	10 30		0.240	0.500	0.017	0.005K	0.040
73/11/04	09 10		0.326	0.350	0.026	0.008	0.020
73/12/16	15 15		0.320	0.200	0.020	0.008	0.020
74/01/03	09 30		1.140	0.900	0.060	0.005K	0.020
74/02/04	15 15		0.520	1.000	0.035	0.005K	0.025
74/02/18	15 15		0.450	0.300	0.020	0.005K	0.025
74/03/02	15 15		0.680	0.600	0.020	0.010	0.030
74/04/20	15 15		0.004	0.300	0.015	0.005	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/03

+20401
+1 41 55.0 080 18 25.0
UNNAMED STREAM
42 7.5 CONNEAUT PRK
1/CONNEAUT LAKE
PA HWY 618 BRDG .7 MI NE OF CONNEAUTLKPK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/05/14	10	15	0.520	0.480	0.022	0.009	0.020
73/06/04	10	00	0.620	0.640	0.054	0.011	0.025
73/07/06	10	03	0.930	0.700	0.220	0.036	0.075
73/08/11	10	20	0.620	0.540	0.046		0.045
73/09/06	10	15	0.370	0.450	0.130	0.025	0.100
73/10/20	10	45	0.145	1.100	0.330	0.040	0.155
73/11/04	09	00	0.208	0.800	0.024	0.008	0.025
73/12/16	15	30	0.440	0.300	0.016	0.0058	0.0058
74/01/05	09	45	1.180	0.300	0.032	0.0058	0.020
74/02/03	15	30	0.350	0.500	0.025	0.0058	0.040
74/02/18	15	30	0.320	0.400	0.015	0.0058	0.040
74/03/02	15	30	0.450	0.500	0.025	0.015	0.065
74/04/20	15	30	0.004	0.300	0.015	0.010	0.010

K VALUE KNOWN TO BE
LESS THAN INDICATED